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Hazzard et al.

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(54) **MOUNTING BRACKET FOR USE WITH A WATER HEATER**

(75) Inventors: **Fritz Hazzard**, Plymouth, MN (US); **Gregory Young**, Richfield, MN (US); **Don C. Kennedy**, Brooklyn Park, MN (US)

(73) Assignee: **Honeywell International Inc.**, Morristown, NJ (US)

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(51) **Int. Cl.**

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F24H 9/06 (2006.01)
F24H 9/18 (2006.01)

(52) **U.S. Cl.**

CPC ***F24H 9/06*** (2013.01); ***F24H 9/1818*** (2013.01); ***F24H 9/1836*** (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

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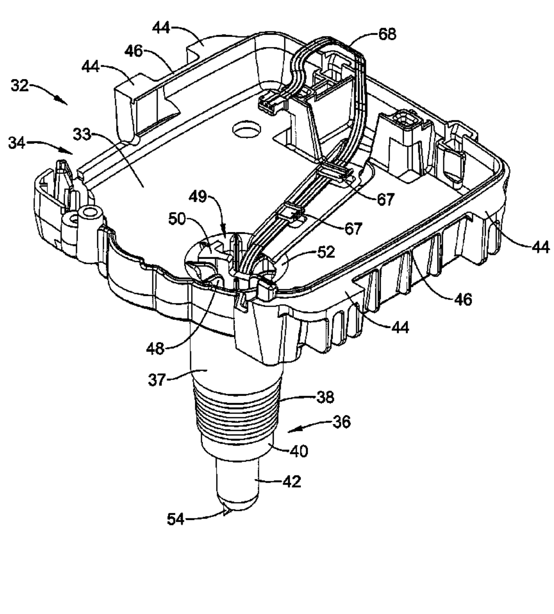
Primary Examiner — Monica Millner

(74) *Attorney, Agent, or Firm* — Seager, Tufte & Wickhem LLP

(57) **ABSTRACT**

A mounting bracket for mounting a temperature sensor, a gas valve, a power delivery unit, a controller and/or any other suitable object or device to a water heater tank or other appliance. An illustrative but non-limiting example may be found in a mounting bracket that includes a polymeric body that has a sensor portion configured to receive a temperature sensor. The sensor portion may have a distal end that extends into and supports the temperature sensor within the water heater tank. The polymeric body may also includes a threaded portion that is configured to threadably engage a threaded spud in a water heater tank such that the distal end of the sensor portion extends into the water tank of the water heater. Various features for increasing the strength and durability of the bracket are also disclosed.

16 Claims, 15 Drawing Sheets



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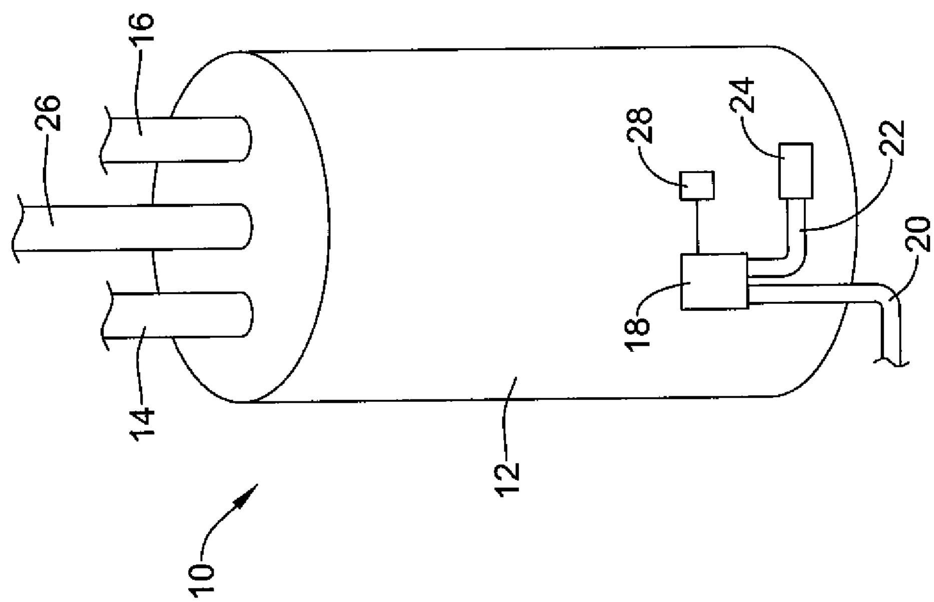


Figure 1

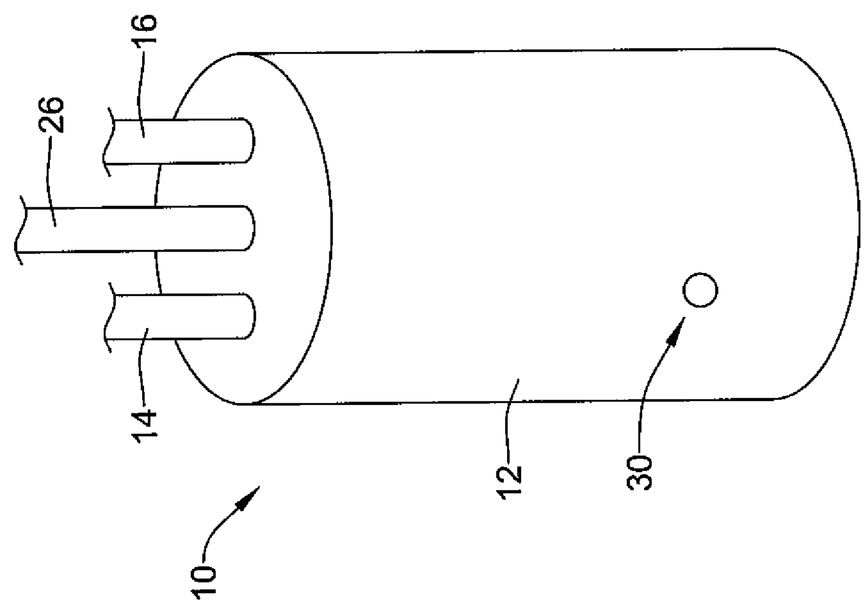


Figure 2

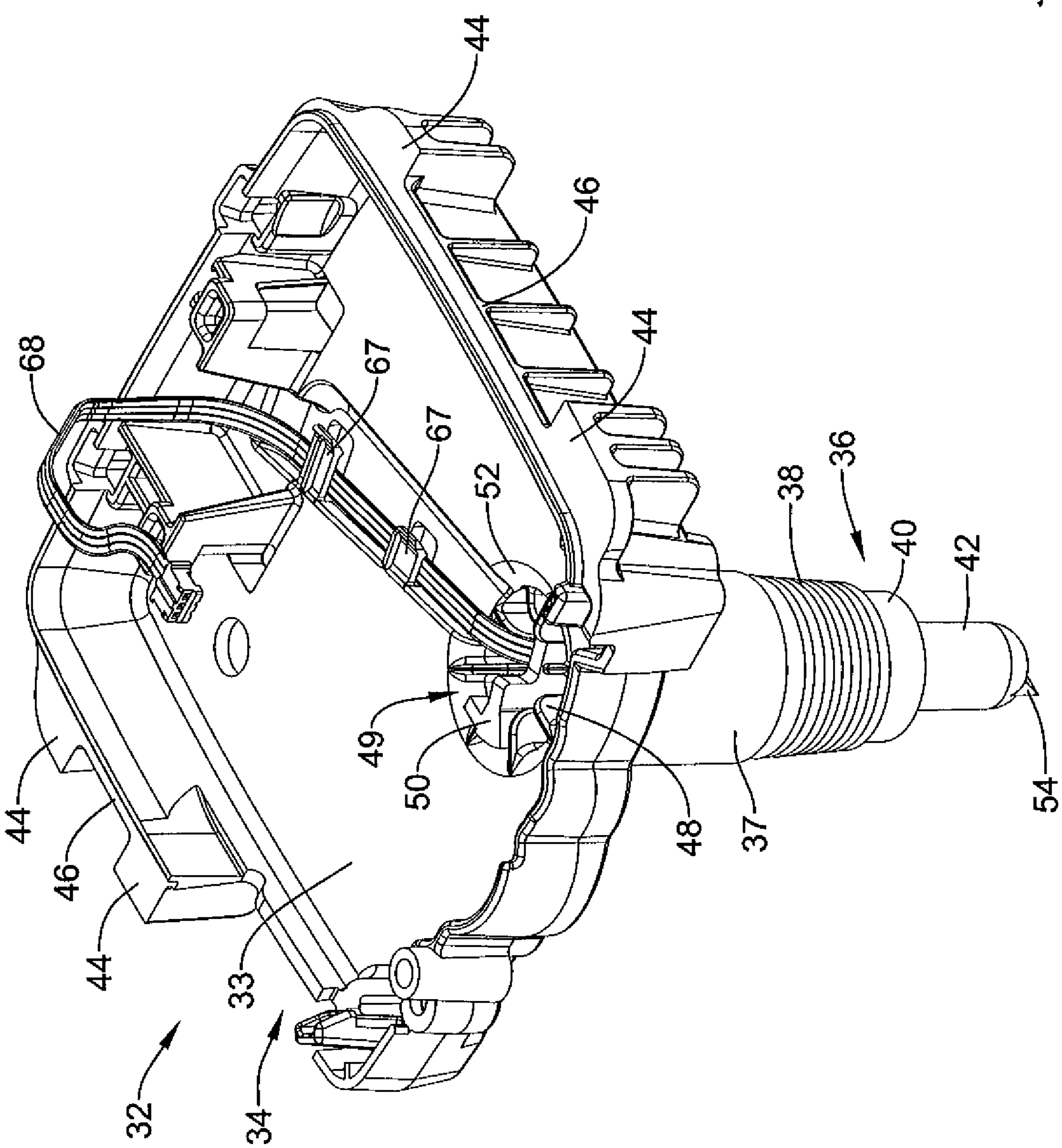
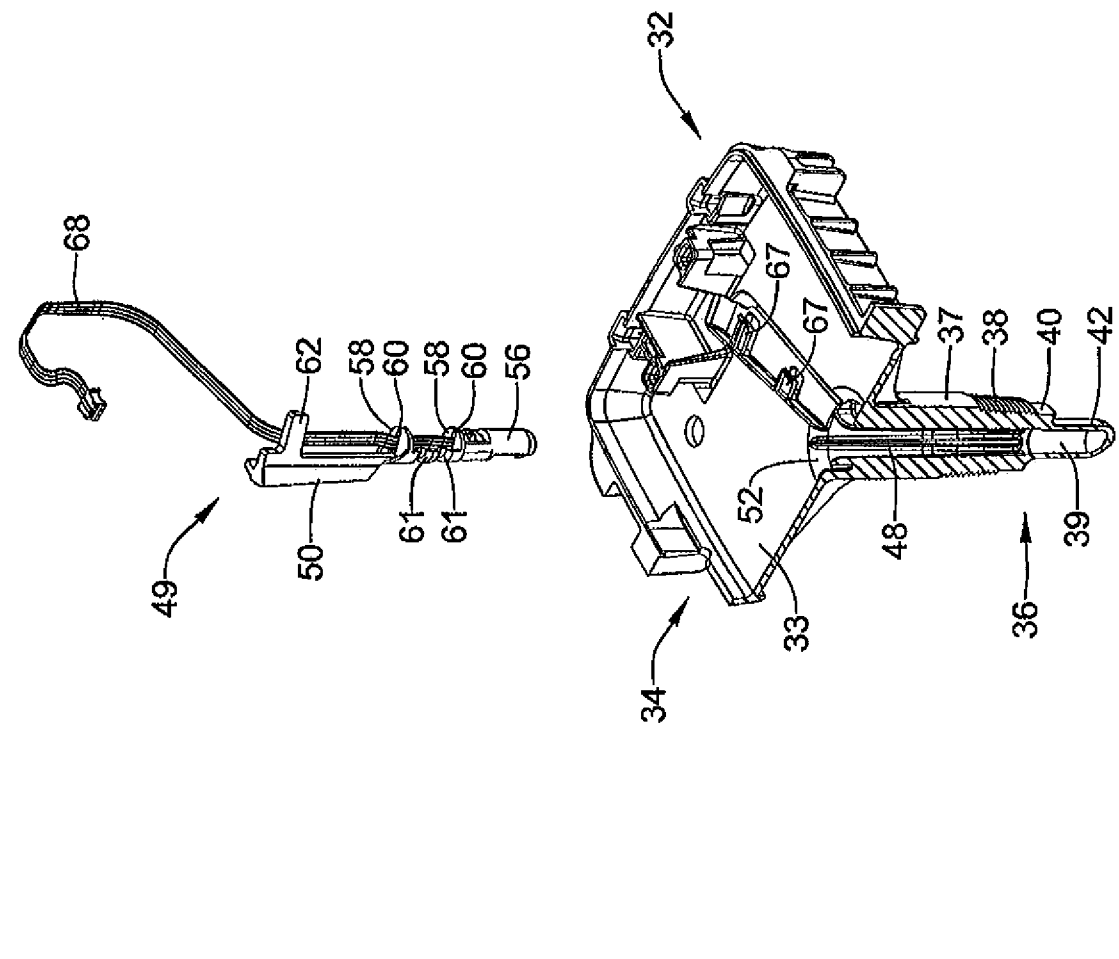


Figure 3

Figure 4



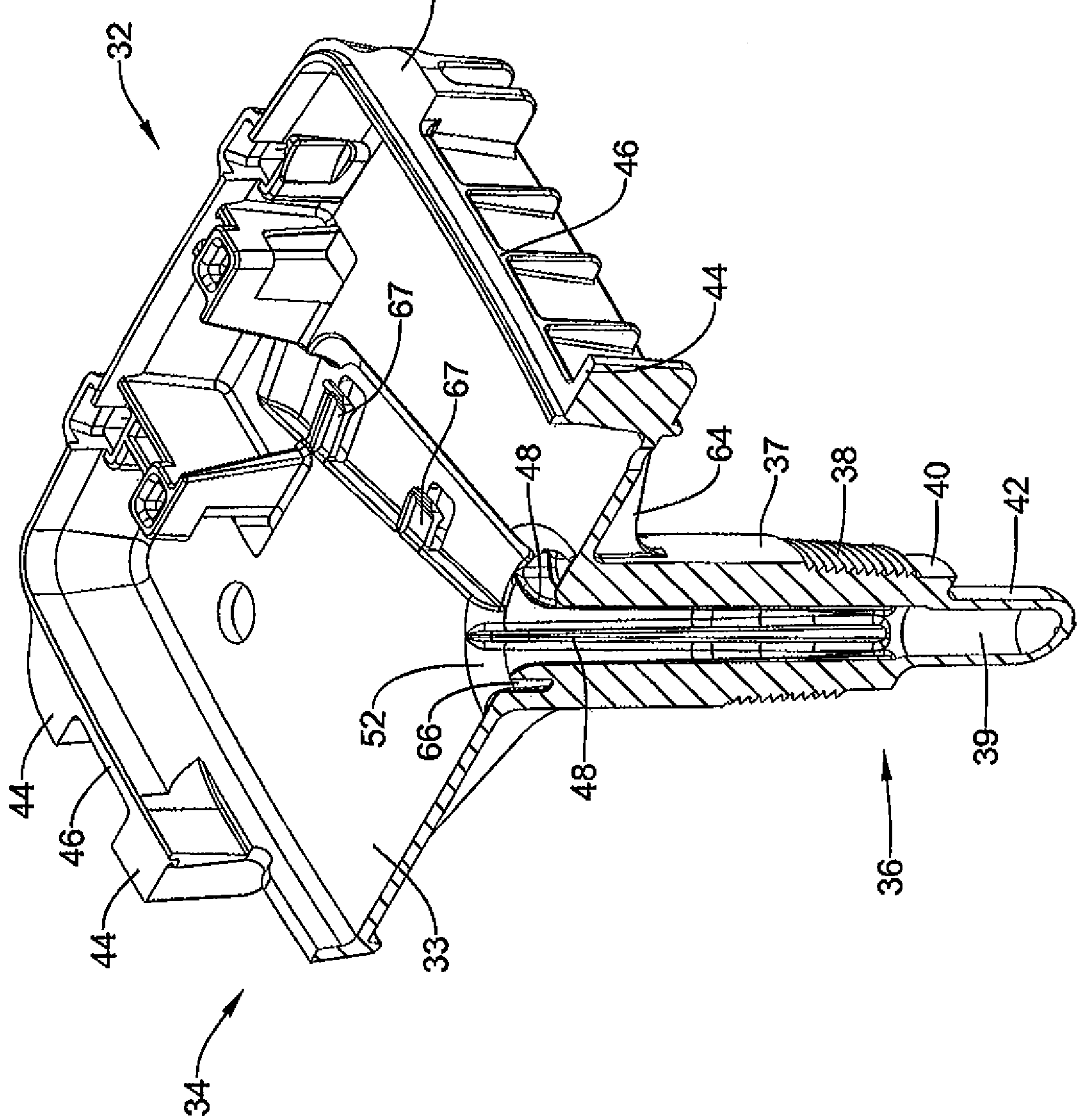


Figure 4A

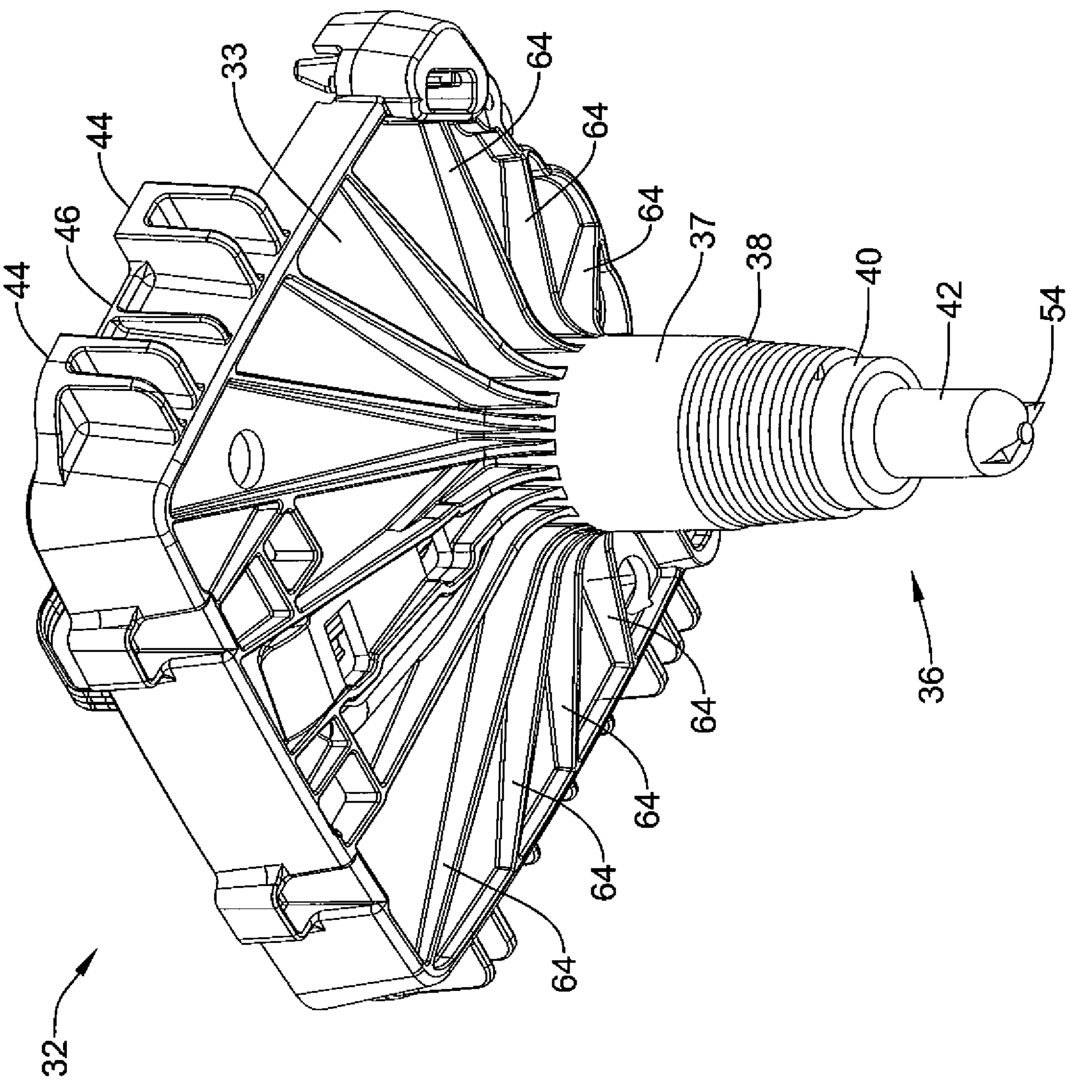


Figure 5

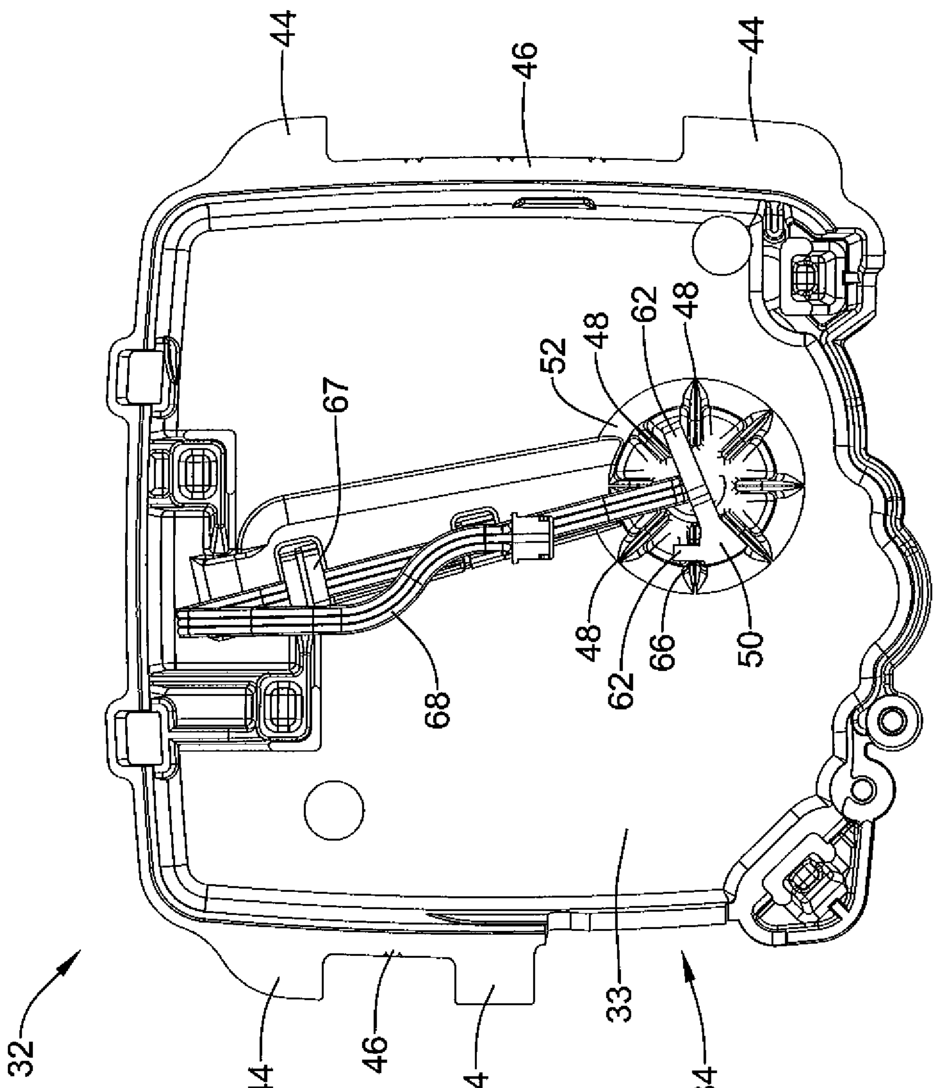


Figure 6

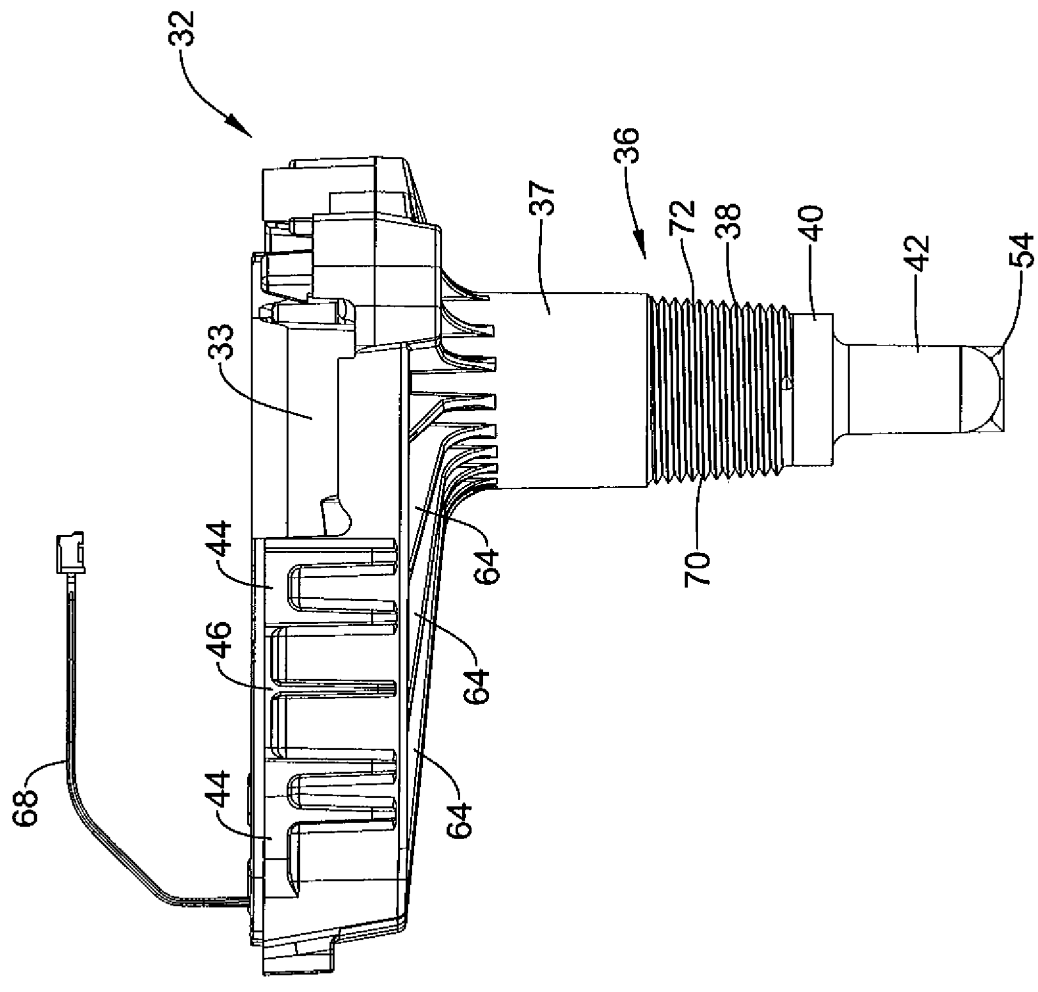


Figure 7

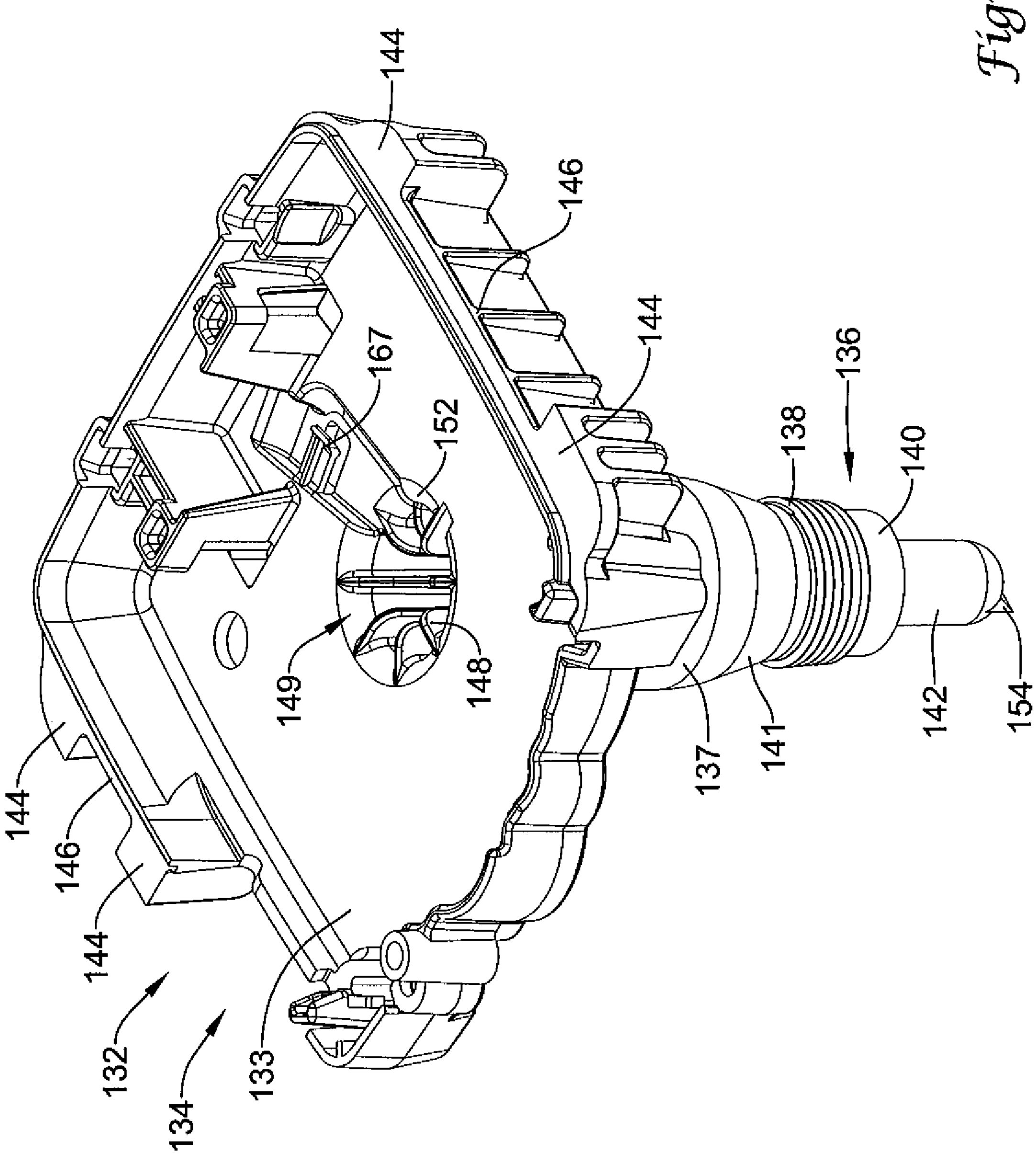

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Figure 8

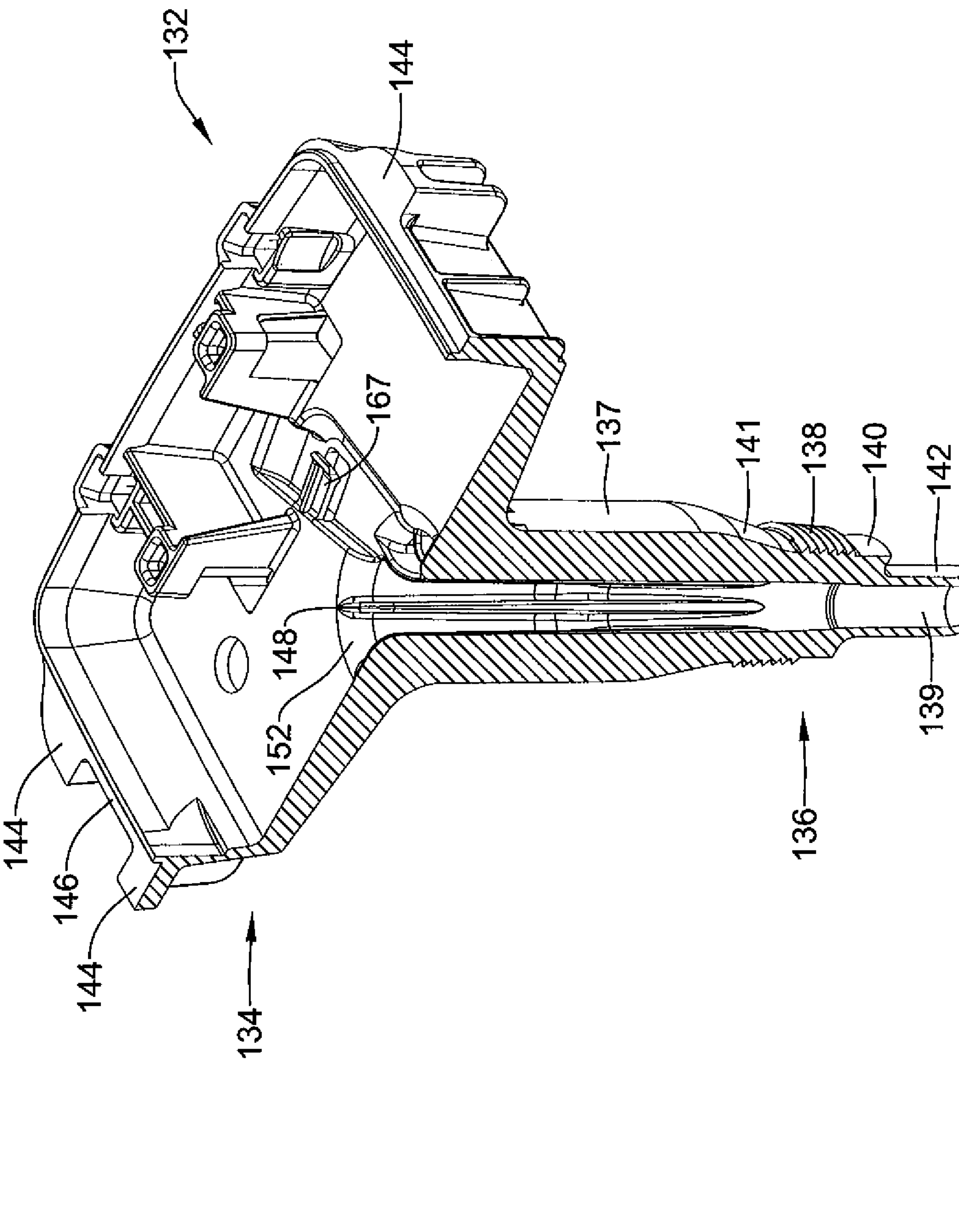
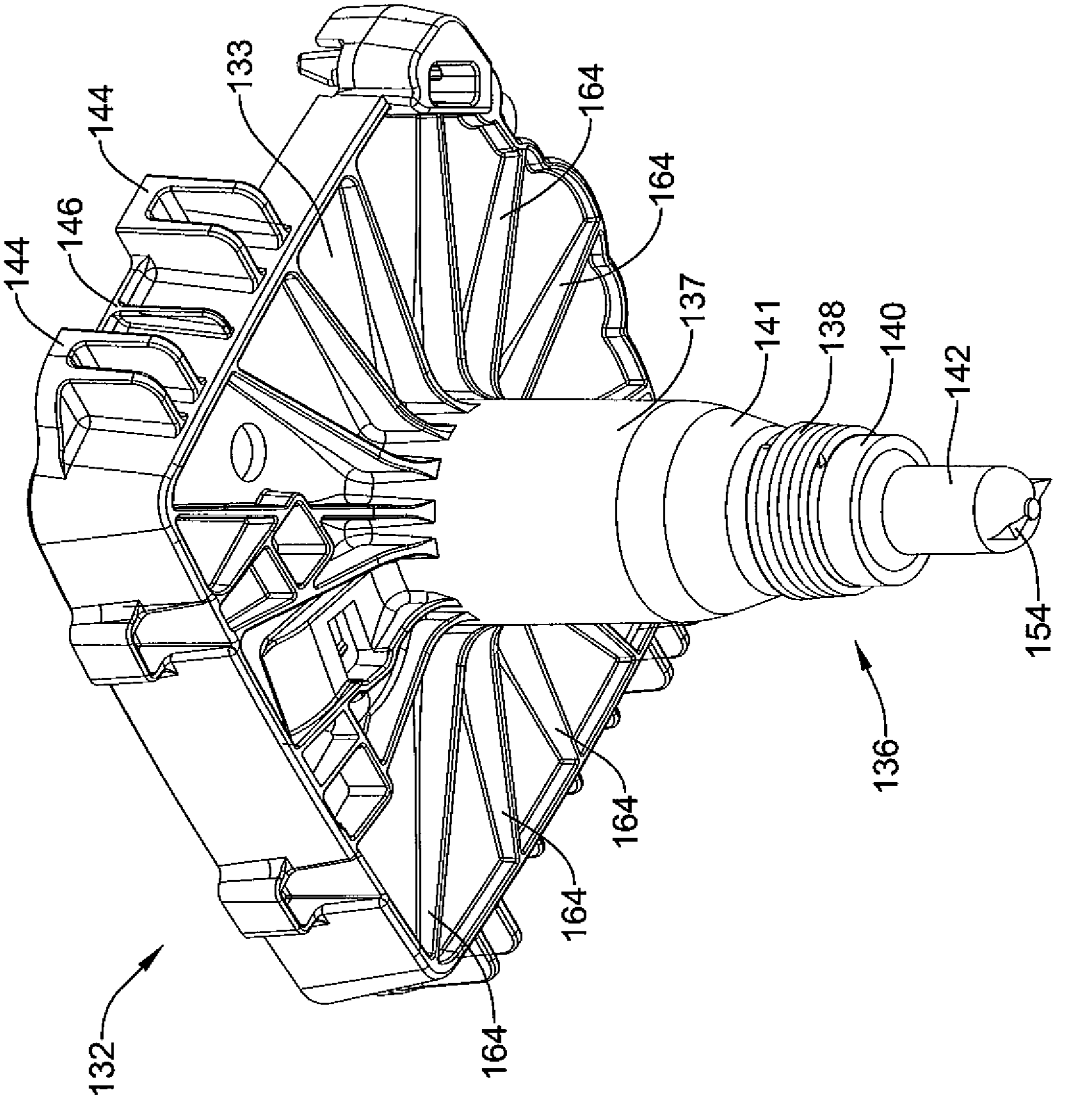


Figure 9

Figure 10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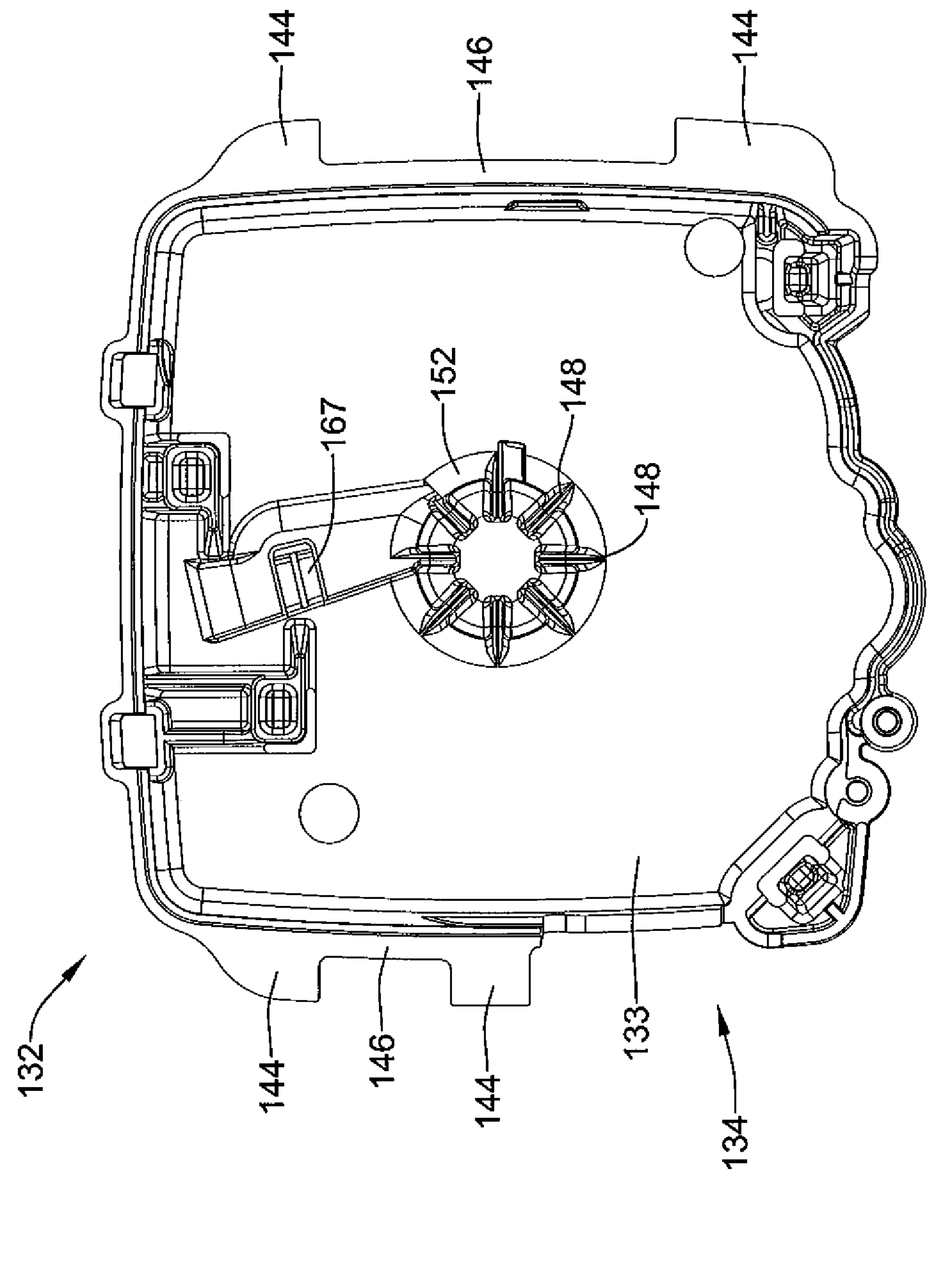

Figure 11

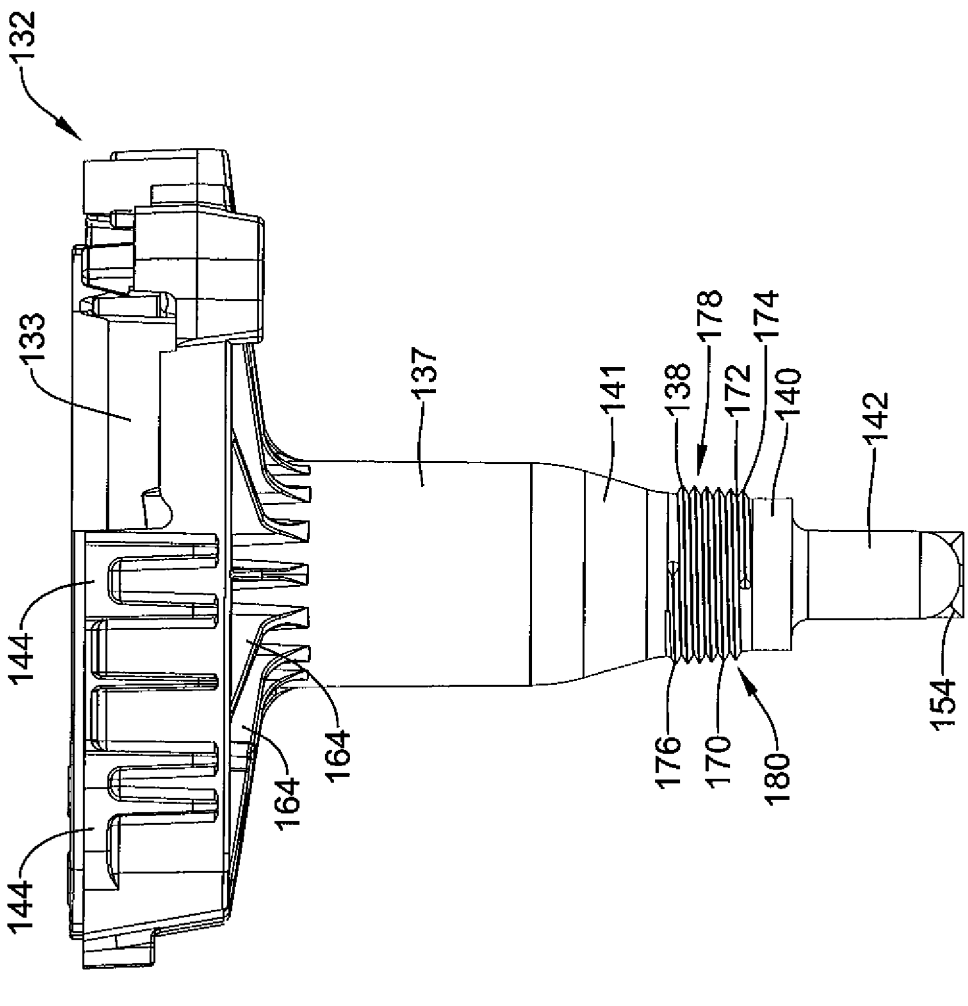

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Figure 12

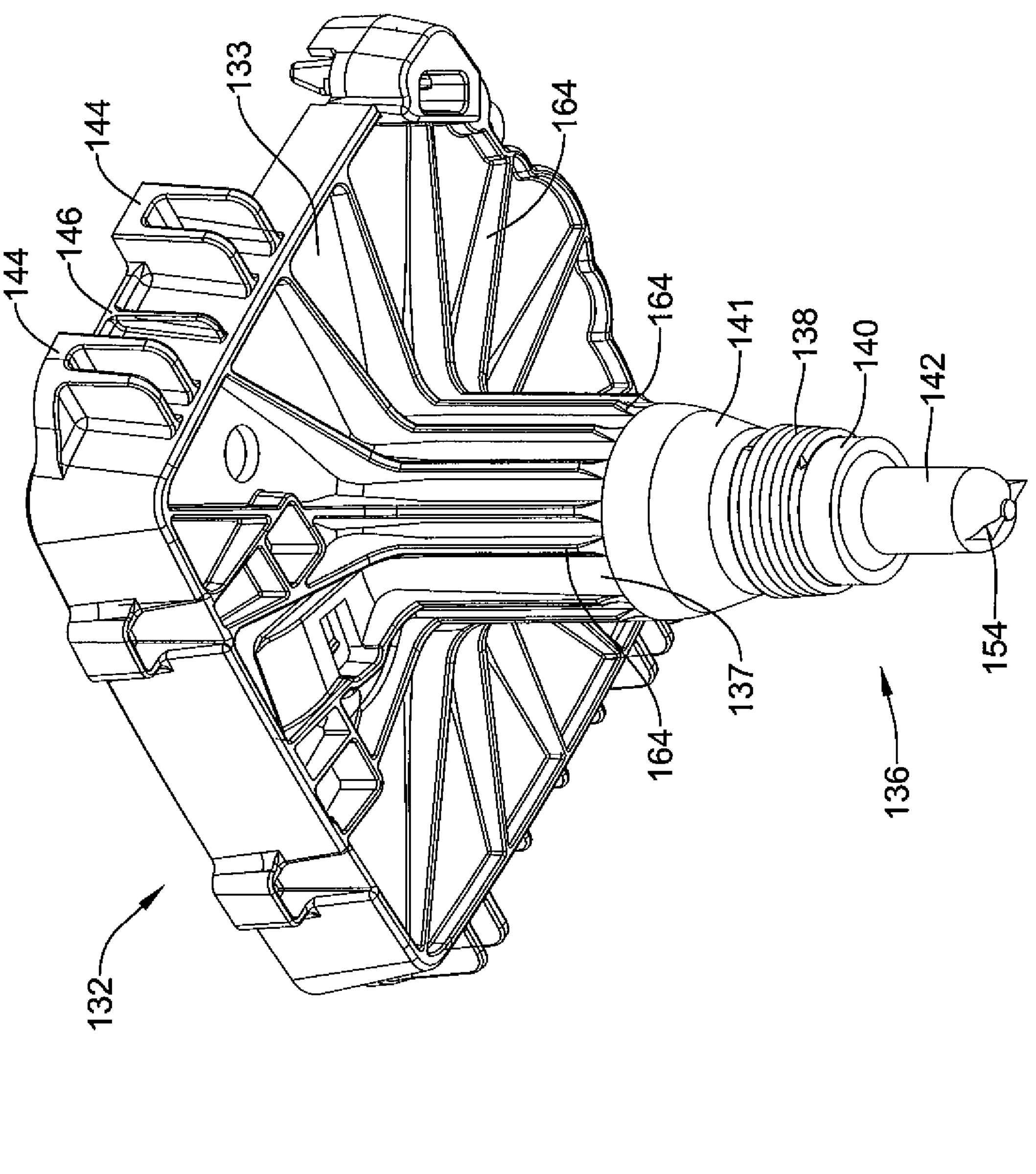

Figure 13

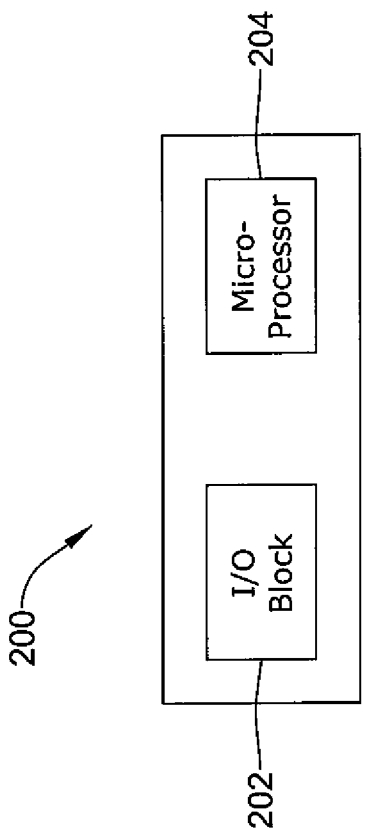

Figure 14

MOUNTING BRACKET FOR USE WITH A WATER HEATER

This application is a Continuation-In-Part (CIP) of U.S. patent application Ser. No. 12/642,449, filed Dec. 18, 2009, and entitled "MOUNTING BRACKET FOR USE WITH A WATER HEATER", which is incorporated hereby by reference.

TECHNICAL FIELD

The disclosure relates generally to water heaters, and more particularly, to a mounting bracket for a water heater for mounting a temperature sensor, a gas valve, a power delivery unit, a controller and/or any other suitable object or device to the water heater.

BACKGROUND

Water heaters are used in homes, businesses and just about any establishment having the need for heated water. A conventional water heater typically has at least one heating element or "heater," such as a gas-fired and/or electric burner. Each water heater also typically has at least one thermostat or controller for controlling the heater. The controller typically receives signals related to the temperature of the water within the water heater tank, often from a temperature sensor that is thermally engaged with the water in the water heater tank.

In some instances, a water heater may operate in accordance with a first temperature set point and a second temperature set point. The difference between the first and second temperature set point may be referred to as the temperature differential of the water heater. When temperature signals from the temperature sensor indicate that the water temperature is below the first set point, for example when the water temperature is below about 120° F., the controller may turn on the heater and the water within the water heater tank begins to heat. After some time, the water temperature within the water heater tank will increase to the second set point, which, for example may be about 140° F. At this point, the controller may cause the heater to reduce its heat output or, alternatively, causes the heater to turn off. This heat cycle begins again when the water temperature within the water heater tank cools down below the first set point.

For a gas fired water heater, a temperature sensor, a gas valve and a controller are often mounted relative to the water heater tank. The controller typically receives a temperature signal from the temperature sensor. The temperature sensor often protrudes into and is thermally coupled to the water in the water heater tank. The controller typically is programmed to control the gas valve such that the temperature of the water in the water heater tank remains between the first and second temperature set points, as described above. For an electric water heater, a temperature sensor, a power delivery unit and a controller may be mounted to the water heater tank. In this case, the controller may control the power delivery unit such that the temperature of the water in the water heater tank is kept between the first and second temperature set points.

What would be desirable is an improved mounting bracket for mounting the temperature sensor, the gas valve, the power delivery unit, the controller and/or any other suitable object or device to the water heater tank.

SUMMARY

The present disclosure pertains generally to an improved mounting bracket for mounting a temperature sensor, a gas valve, a power delivery unit, a controller and/or any other suitable object or device to a water heater tank. An illustrative but non-limiting example of the disclosure may be found in a mounting bracket that includes a polymeric body that has a sensor portion configured to receive a temperature sensor. The sensor portion may have a distal end that extends into and supports the temperature sensor within the water heater tank. The polymeric body may also include a threaded portion that is configured to threadably engage a threaded spud in a water heater tank such that the distal end of the sensor portion extends into the water tank of the water heater.

In some cases, the sensor portion may include an elongated stem that has an internal well for receiving the temperature sensor. The threaded portion may extend around the elongated stem. In some instances, the elongated stem may include a thread lead in region between the threaded portion and the distal end of the elongated stem. The thread lead in region may help guide the mounting bracket relative to the water heater while the sensor portion is inserted into the water heater tank but before the threaded portion of the stem threadably engages the threaded spud of the water heater. In some cases, the distal end of the elongated stem may include a blade element that can be used to help pierce a barrier or the like of the water heater when the mounting bracket is installed on the water heater.

In some embodiments, the mounting bracket may include a component retaining region. The component retaining region may be use to retain a gas valve, a power delivery unit, a controller and/or any other suitable object or device relative to the water heater tank. In some cases, the component retaining region may include two or more ribs for providing additional support to the component retaining region. In some instances, the two or more ribs may radiate out from the elongated stem, but this is not required. In some cases, the polymeric body may be molded as a single piece, and may be made from a material that, when sufficiently stressed, suddenly fractures in a clean break, such as some nylon materials. In some instances, the polymeric body may be configured to suddenly fracture at or near an outside edge of the threaded spud, but this is not required in all embodiments.

BRIEF DESCRIPTION OF THE FIGURES

The following description should be read with reference to the drawings. The drawings, which are not necessarily to scale, depict selected embodiments and are not intended to limit the scope of the disclosure. The disclosure may be more completely understood in consideration of the following detailed description of various embodiments in connection with the accompanying drawings, in which:

FIG. **1** is a schematic view of an illustrative but non-limiting water heater in accordance with the present disclosure;

FIG. **2** is a schematic view of an illustrative but non-limiting water heater in accordance with the present disclosure;

FIG. **3** is a perspective view of an illustrative but non-limiting mounting bracket that may be used in conjunction with the water heater of FIG. **1**;

FIG. **4** is a perspective view, partially in cross-section, of an illustrative but non-limiting mounting bracket and temperature sensor assembly;

FIG. **4**A is a perspective view, partially in cross-section, of the illustrative but non-limiting mounting bracket of FIG. **4**, with the temperature sensor assembly not shown;

FIG. **5** is another perspective view of the illustrative but non-limiting mounting bracket of FIG. **3**;

FIG. **6** is a top plan view of the illustrative but non-limiting mounting bracket of FIG. **3**;

FIG. **7** is a side view of the illustrative but non-limiting mounting bracket of FIG. **3**;

FIG. **8** is a perspective view of an illustrative but non-limiting mounting bracket that may be used in conjunction with the water heater of FIG. **1**;

FIG. **9** is a perspective view, partially in cross-section, of the illustrative but non-limiting mounting bracket of FIG. **8**;

FIG. **10** is another perspective view of the illustrative but non-limiting mounting bracket of FIG. **8**;

FIG. **11** is a top plan view of the illustrative but non-limiting mounting bracket of FIG. **8**;

FIG. **12** is a side view of the illustrative but non-limiting mounting bracket of FIG. **8**;

FIG. **13** is a perspective view of another illustrative but non-limiting mounting bracket; and

FIG. **14** is a block diagram of a controller that may be used with the water heater of FIG. **1**.

While the invention is amenable to various modifications and alternative forms, specifics thereof have been shown by way of example in the drawings and will be described in detail. It should be understood, however, that the intention is not to limit the invention to the particular illustrative embodiments described. On the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention.

DESCRIPTION

For the following defined terms, these definitions shall be applied, unless a different definition is given in the claims or elsewhere in this specification.

All numeric values are herein assumed to be modified by the term “about”, whether or not explicitly indicated. The term “about” generally refers to a range of numbers that one of skill in the art would consider equivalent to the recited value (i.e., having the same function or result). In many instances, the term “about” may be indicative as including numbers that are rounded to the nearest significant figure.

The recitation of numerical ranges by endpoints includes all numbers within that range (e.g., 1 to 5 includes 1, 1.5, 2, 2.75, 3, 3.80, 4, and 5).

Although some suitable dimensions ranges and/or values pertaining to various components, features and/or specifications are disclosed, one of skill in the art, incited by the present disclosure, would understand desired dimensions, ranges and/or values may deviate from those expressly disclosed.

The following description should be read with reference to the drawings, in which like elements in different drawings are numbered in like fashion. The drawings, which are not necessarily to scale, depict selected embodiments and are not intended to limit the scope of the invention. Although examples of construction, dimensions, and materials are illustrated for the various elements, those skilled in the art will recognize that many of the examples provided have suitable alternatives that may be utilized.

FIG. **1** provides a schematic view of an illustrative but non-limiting water heater **10**. Water heater **10** includes a water tank **12**. The water tank **12** may include an insulating layer (not explicitly shown) positioned about the water tank **12** to help reduce thermal losses from the water tank **12**. Cold water enters water tank **12** through a cold water line **14** and is heated by a gas burner **24**. In some cases, the water heater **10** may include an electric heating element rather than a gas burner **24**. A power delivery unit (not shown) may be used to selectively apply power (i.e. current) to the electric heating element. In either case, the resulting heated water exits through a hot water line **16**. For gas-fired water heaters, a gas control unit **18** such as a gas valve regulates gas flow from a gas source **20** through a combustion gas line **22** and into gas burner **24**. A flue **26** permits combustion byproducts to safely exit.

As can be seen, water heater **10** includes a temperature sensor **28**. In some cases, temperature sensor **28** may enter water tank **12** at a location laterally offset from gas control unit **18**. In some instances, however, temperature sensor **28** may instead be located behind gas control unit **18**, and in some cases, may be supported and retained by a common mounting bracket such as that described more fully below. In any event, water tank **12** may include an aperture **30** that is sized and configured to accept temperature sensor **28**. This can be seen in FIG. **2**, in which certain elements of FIG. **1** have been removed for clarity. Aperture **30** may include threads that are configured to accommodate corresponding matching threads on temperature sensor **28**. In some cases, temperature sensor **28** has a compression or frictional fit within aperture **30**. In other instances, water tank **12** may include a threaded spud (not explicitly shown) that is configured to receive temperature sensor **28**.

FIG. **3** is a perspective view of an illustrative but non-limiting mounting bracket **32** that may be used in conjunction with the water heater **10**. In some instances, the mounting bracket **32** may include a component retaining region **33** and a sensor portion **36** forming an elongated stem. Bracket **32** may be configured to retain a gas valve module and/or a water heater controller module (not explicitly shown) within component retaining region **33**, as well as a temperature sensor assembly **49** (see also FIG. **4**) within elongated sensor portion **36**. In the illustrative embodiment, bracket **32** includes a gas valve retaining portion **34** and a sensor portion **36**. Gas valve retaining portion **34** may form at least a portion of a housing of a gas control unit, such as gas control unit **18** of FIG. **1**, but this is not required. In some instances, as illustrated, elongated sensor portion **36** may include a threaded portion **38** that can be used to secure bracket **32** to or within aperture **30** (FIG. **2**) of water heater spud.

Bracket **32** may be formed of any suitable material. In some cases, bracket **32** may include non-metallic materials such as a polymeric material, glass, ceramic, plastic, and the like. In some cases, bracket **32** may be manufactured as a single piece by injection molding a nylon material such Zytel® 70G33 glass-filled nylon, available from DuPont in Wilmington, Del. The thermal conductivity of such non-metallic materials may be less than those of metallic materials, and as a result, may partially thermally isolate the temperature sensor assembly **49** from the water in the water tank **12**, but may be less expensive to produce than a metallic well. It is contemplated that in some cases, bracket **32** may not be formed entirely from the same material, or bracket **32** may not be formed as a single piece. As will be discussed in more detail with respect to FIG. **7**, bracket **32** may incorporate safety features to prevent injury from hot water in the event bracket **32** becomes broken or damaged after installation.

Sensor portion **36** of the bracket **32** may include an elongated stem extending from component retaining region **33**. Sensor portion **36** may include an internal well **39** (shown in more detail in FIGS. **4** and **4**A) for receiving a temperature sensor assembly **49**. The elongated stem of sensor portion **36** may include of several different regions. For example, sensor portion **36** may include a first portion **37**, a threaded region **38** extending around the exterior of the sensor portion **36**, a thread lead-in region **40**, and an enclosed distal end region **42**. Threaded region **38** may be configured to threadably engage a threaded spud in the water tank **12**. Thread lead-in region **40** may be disposed between the distal end region **42** and the threaded region, and may be configured to help guide the sensor portion **36** into the aperture **30** of the water tank **12** with proper alignment for the threaded region **38** to engage the threaded spud in the water tank **12**. In some embodiments, the thread lead-in region **40** may have zero draft for maximum effectiveness, but this is not required. When threaded region **38** is engaged with the threaded water heater spud, distal end **42** may be disposed within water tank **12**. Distal end **42** may house a temperature sensor such that when the bracket **32** is engaged with the water tank **12**, the temperature sensor is in at least partial thermal contact with the water in the water tank **12**.

In some instances, distal end region **42** may have a reduced cross-sectional area relative to remaining regions **37**, **38** and **40** of sensor portion **36**. However, it is contemplated that in some cases, the cross-sectional area of distal end **42** may be the same as, or substantially the same as the remaining regions **37**, **38** and **40** of sensor portion **36**. In some embodiments, distal end **42** may include a cutting element **54** disposed at or near the tip. In some instances, the cutting element **54** may include a blade-like feature. Cutting element **54** may be capable of puncturing and/or piercing a plastic sheet or barrier commonly wrapped around the water tank **12** of many water heaters during installation of the bracket **32**. It is contemplated that in some cases, the cutting element **54** may be omitted from the design.

In some embodiments, bracket **32** may also include two (or more) bosses **44** on a first lateral side, and two (or more) bosses **44** on a second opposing lateral side. While bracket **32** is shown having four bosses **44**, it is contemplated that bracket **32** may have any number of bosses **44** as desired, for example, but not limited to, one, two, three, or more. Additionally, it is contemplated that bosses **44** may be disposed on fewer than, or more than, two lateral sides. Bosses **44** may provide, among other things, an area for torque to be applied directly to the bracket **32** during installation. For example, an installation tool may grip and apply torque to bosses **44** to threadably engage threaded region **38** of sensor portion **36** with the threaded water heater spud on a water tank **12**. In some instances, bosses **44** may further include a rib **46** disposed between adjacent bosses **44**. Rib(s) **46** may provide additional support to the bracket **32**, and may also help prevent an installation tool from contacting the component retaining region **33** of bracket **32** during installation.

Turning now to FIG. **4**, which is a perspective view, partially in cross-section, of an illustrative but non-limiting mounting bracket **32** and temperature sensor assembly **49**. The temperature sensor assembly **49** is shown pulled out of the sensor region **36** and situated above the bracket **32** in an exploded view form. As can be seen, the sensor portion **36** may be configured to accommodate the temperature sensor assembly **49**. In the illustrative embodiment, temperature sensor assembly **49** includes one or more heat traps **58** that are attached to or otherwise secured to sensor assembly structure **50**, and may serve to help limit or at least partially limit heat flow out of the sensor portion **36** of the bracket **32**. Sensor assembly structure **50** may further include one or more convolutions **61**. When the sensor assembly structure **50** is assembled within sensor portion **36**, convolutions **61** may apply a spring-like force that holds the temperatures sensor **56** in tight contact with the bottom of the internal well **39**. Convolutions **61** may also reduce the need to use a fastener to secure the temperature sensor assembly **49**. Temperature sensor assembly **49** may be configured to accommodate a temperature sensor **56**. In some cases, temperature sensor **56** may be a single temperature sensor. In other instances, temperature sensor **56** may include multiple temperature sensors, which may provide a measure of redundancy and/or increased accuracy in a corresponding temperature measurement. In some cases, the temperature sensor **56** may include a thermopile or thermocouple.

During assembly, it will be appreciated that heat traps **58** and temperature sensor **56** may be attached to a sensor assembly structure **50**. This may be accomplished by snap fits, frictional fits, glue, screws, rivets, or any other suitable attachment mechanism. In some instances, heat traps **58** may be integrally molded or otherwise formed as part of sensor assembly structure **50**. In some cases, the heat traps **58** may each include a slot **60** in order to accommodate and/or secure a wiring harness **68** for the temperature sensor **56**. Once heat traps **58** and temperature sensor **56** have been secured or otherwise attached to sensor assembly structure **50**, sensor assembly structure **50** may be inserted into a void **52** that is molded or otherwise formed within sensor portion **36**. It can be seen that sensor assembly structure **50** may include one or more protrusions such as protrusion **62** that may help to locate sensor assembly structure **50** within void **52** and/or limit penetration of sensor assembly structure **50** into void **52** while allowing wiring harness **68** to pass without being pinched. The one or more protrusions **62** may align the sensor assembly structure **50** with inwardly extending ribs **48** disposed on the inner walls of the sensor portion **36** and into the void. One or more protrusions **62** in cooperation with one or more ribs **48** may, in some instances, help properly align and assemble the temperature sensor assembly **49** within the sensor portion **36**. One or more protrusions **62** may also ensure that sensor assembly **49** is not installed in the wrong bracket. As can be seen, when temperature sensor assembly **49** is assembled within sensor portion **36**, sensor **56** may be disposed within an internal well **39** within the distal tip portion **42** of the sensor portion.

FIG. **4A** is a perspective view, partially in cross-section, of the illustrative but non-limiting mounting bracket of FIG. **4**, with the temperature sensor assembly not shown. As discussed above, the void **52** within the sensor region **36** may include inwardly extending ribs **48**. Ribs **48** may extend any length along the void **52**, as desired. While ribs **48** are shown extending to a distal end of threaded region **38**, it is contemplated in some embodiments, ribs **48** may extend past threaded region **38**. In other embodiments, ribs **48** may terminate short of threaded region **38**, or at any point within threaded region **38**. It is further contemplated that there may be any number of ribs **48** as desired, for example, but not limited to, one, two, three, four, or more. In some embodiments, sensor portion **36** may include one or more slots **66** for receiving one or more protrusions such as protrusion **62** that may help locate temperature assembly structure **50** within void **52** and/or limit penetration of temperature assembly structure **50** into void **52**.

FIG. **5** is another perspective view of the illustrative but non-limiting mounting bracket of FIG. **3**. In the illustrative but non-limiting example, the bracket **32** includes a number of outer ribs **64** extending along the back of component retaining region **33** of bracket **32** and to the first region **37** of sensor portion **36**. For clarity, not all ribs **64** have been identified with a reference numeral. In some cases, outer ribs **64** may not extend all the way to sensor portion **36**, while in other cases, ribs **64** may extend further along sensor portion **36** towards threaded region **38**. The number of ribs **64** may vary as desired depending on the application. For example, bracket **32** may have zero ribs **64**, as few as one rib **64**, more than 14 ribs, or any other number of ribs **64** as desired. As shown, the ribs **64** may radiate out from the elongated stem of the sensor region **36**, but this is not required.

It is contemplated that the ribs **64** may provide additional strength to bracket **32**. In some cases, the ribs **64** may be sufficient for the bracket **32** to withstand a 500 pound-force (lbf) static vertical load (roughly equivalent to a 300 lb person stepping on the installed bracket). When so provided, bracket **32** may resist accidental breakage. In the event bracket **32** breaks or fails, however, bracket **32** may have other safety features to help prevent a user from being exposed to hot water from the water tank **12**, as will be discussed in more detail below with respect to FIG. **7**.

FIG. **6** is a top plan view of the illustrative but non-limiting mounting bracket **32** of FIG. **3**, with the temperature sensor assembly **49** positioned within void **52** such that temperature sensor **56** is disposed within the internal well **39**. As discussed above, and in some embodiments, one or more protrusions **62** may be positioned between internal ribs **48** or within slot **66**. Internal ribs **48** may be radially spaced within void **52**. While ribs **48** are illustrated as equally spaced around the circumference of void **52**, it is contemplated that internal ribs **48** may be spaced at any distance desired, or may not be present at all. Additionally, while void **52** is illustrated as having a circular cross-section, it is contemplated that void **52** may have any cross-section shape as desired, such as, but not limited to, square, rectangular, elliptical, or polygonal. Wiring harness **68** may be configured to extend from temperature sensor assembly **49** and to a gas control unit, such as the gas control unit **18** illustrated in FIG. **1**. Component retaining region **33** may include retaining elements **67** for retaining wiring harness **68**. Retaining elements **67** may be molded in such a way as to allow the use of an optical sensor in production to ensure that the wiring harness **68** and/or sensor wires are properly installed. For example, bracket **32** may be molded such that an opening is present behind retaining elements **67**. While not explicitly shown, component retaining region **33** may also include retaining elements for retaining a water heater controller module and/or gas valve module, if desired.

FIG. **7** is a side view of the illustrative but non-limiting mounting bracket of FIG. **3**, with the temperature sensor assembly **49** disposed within void **52** (not explicitly shown). Threaded region **38** may be configured to provide additional safety features to bracket **32**, if desired. For example, threaded region **38** may include a plurality of threads **70** spaced a distance apart. Geometric dimensioning and tolerancing may be used to control the angle and roundness of the threads **70**. In some embodiments, threads **70** may be spaced such that there are 13.9-14.0 threads per inch. In other embodiments, it is contemplated that there may be more or fewer threads per inch. In one example, threads **70** may be spaced to ensure that the material in the threads **70** is in compression, and not in tension. This may increase the strength of the threaded region **38** when torque is being applied during installation of the bracket **32**, as well as increasing the strength to support a vertical load. In some cases, threaded region **38** may be able to withstand 75 foot-pounds (ft-lbs), or more, of torque. In some embodiments, the root **72** of threads **70** may be rounded to relieve stress in the threads **70**. A round root **72** may increase the strength during application of torque as well as for a vertical load.

In the event that a torque or a vertical load is applied to the bracket **32** that exceeds the design load limits, or the bracket **32** is otherwise sufficiently stressed, bracket **32** may break in a sudden manner resulting in a brittle fracture. A suitable material for creating such a break is Dupont™ Zytel® 70G33, however, other materials may be used. The stress from such an event may be concentrated in the last thread **70** that engages the water heater spud. A brittle material may result in a clean break at or near the outside edge of the water heater spud such that the portion of the sensor portion **36** that has been threadably engaged with the water heater spud remain positioned within the water heater spud. For example, if a breakage occurs, the distal portion **42** and part of the threaded region **38** of the sensor portion **36** may remain disposed within the water tank **12** and water heater spud. This may help prevent significant leakage of hot water from the water heater. Once the water is removed, or the water is cooled, the internal ribs **48** (see FIG. **6**) disposed within the void **52** may be used to axially align a removal tool, for example, an aggressive Easy-Out such as a Walton #4 pipe, stud, and screw extractor or equivalent, and to provide a surface to which torque may be applied to remove the broken off portion of the bracket **32** from the water heater. If ribs **48** are not present in the remaining portion of the sensor portion **36**, a removal tool having sharp blades may dig into the interior surface of the internal well **39** to remove the broken off portion.

In some instances, the mounting bracket **32** may screw into a threaded spud on the side of a water heater **10** and go through the water heater insulation. As the insulation thickness on the water heater **10** increases, the sensor portion **36** on the bracket **32** may need to get longer. A longer sensor portion **36**, however, may decrease the load that the mounting bracket **32** can withstand. In some instances, this may be compounded by the fact that the threads **38** on the sensor portion **36** of the mounting bracket **32** that extend outside of the spud may create a stress riser.

FIG. **8** is a perspective view of an illustrative but non-limiting mounting bracket **132** illustrating an alternative sensor portion **136** that may increase the downward load that the mounting bracket **132** can withstand. Like above, the mounting bracket **132** may include a component retaining portion **133**, and a sensor portion **136** that includes an elongated stem. The illustrative bracket **132** may be configured to retain, for example, a gas valve module and/or a water heater controller module (not explicitly shown) within component retaining region **133**, as well as a temperature sensor assembly (not explicitly shown, see also FIG. **4**) within the sensor portion **136**. In the illustrative embodiment of FIG. **8**, bracket **132** may include a gas valve retaining portion **134** that may form at least a portion of a housing of a gas control unit, such as gas control unit **18** of FIG. **1**, but this is not required. In some instances, and as illustrated in FIG. **8**, elongated sensor portion **136** may include a threaded portion **138** that can be used to secure bracket **132** to or within aperture **30** (FIG. **2**) of a water heater spud.

It is contemplated that bracket **132** may be formed of any suitable material. In some instances, bracket **132** may include non-metallic materials such as a polymeric material, glass, ceramic, plastic, and the like. In some cases, bracket **132** may be manufactured as a single piece by injection molding a nylon material such Zytel® 70G33 glass-filled nylon, available from DuPont in Wilmington, Del. The thermal conductivity of such non-metallic materials may be less than those of metallic materials, and as a result, may partially thermally isolate the temperature sensor assembly from the water in the water tank **12**, but may be less expensive to produce than a metallic well. It is contemplated that in some cases, bracket **132** may not be formed entirely from the same material, or bracket **132** may not be formed as a single piece. In some cases, bracket **132** may include both a metallic material and a non-metallic material. Also, and as will be discussed in more detail with respect to FIG. **12**, bracket **132** may incorporate safety features to help minimize injury from hot water in the event bracket **132** becomes broken or damaged after installation.

Sensor portion **136** of the bracket **132** may include an elongated stem extending from component retaining region **133**. Sensor portion **136** may include an internal well **139** (shown in more detail in FIG. **9**) for receiving a temperature sensor assembly. While the temperature sensor assembly is not explicitly shown, it is contemplated that a temperature sensor assembly similar to that described above with respect to FIGS. **4** and **4**A may be used. The elongated stem of sensor portion **136** may include several different regions. For example, sensor portion **136** may include a first region **137**, a tapered region **141**, a threaded region **138** extending around the exterior of the sensor portion **136**, a thread lead-in region **140**, and an enclosed distal end region **142**. Threaded region **138** may be configured to threadably engage a threaded spud of the water tank **12**. In some cases, the threaded region **138** may provide NPT threads that have a taper angle of between 1 and 8 degrees, and more preferably between 3 an 7 degrees. This may help create a good seal between threaded region **138** and the threads of the water heater spud. Thread lead-in region **140** may be disposed between the distal end region **142** and the threaded region **138**, and may be configured to help guide the sensor portion **136** into the aperture **30** of the water tank **12** with proper alignment for the threaded region **138** to engage the threaded spud in the water tank **12**.

In some embodiments, the thread lead-in region **140** may have zero draft (i.e. has an out wall that is parallel with a central axis of the elongated sensor portion **136**), but this is not required. When threaded region **138** is engaged with a threaded water heater spud, distal end **142** may be disposed within the water tank **12** of the water heater. As such, distal end **142** may house a temperature sensor such that when the bracket **132** is engaged with the water tank **12**, the temperature sensor is in at least partial thermal contact with the water in the water tank **12**.

In some instances, first portion **137** and tapered region **141** may have a larger wall thickness than that of threaded region **138** and thread lead-in region **140**. Tapered region **141** may gradually increase the wall thickness from the threaded region **138** to the first portion **137**, as better shown in FIG. **9**. This may increase the strength of the sensor portion **136** while not providing a discontinuity or sharp change in wall thickness that might create a stress collection region that could provide a fracture point. It is contemplated that in some instances, threaded region **138** may have the same wall thickness or, alternatively, a greater wall thickness than the first portion **137**. In either cases, an increased wall thickness along the elongated sensor portion **136** may help the bracket **132** withstand a greater vertical load.

In some instances, distal end region **142** may have a reduced cross-sectional area relative to remaining regions **137**, **138** and **140** of sensor portion **136**. However, it is contemplated that in some cases, the cross-sectional area of distal end **142** may be the same as, or substantially the same as the remaining regions **137**, **138** and **140** of sensor portion **136**. In some embodiments, distal end **142** may include a cutting element **154** disposed at or near the tip. In some instances, the cutting element **154** may include a blade-like feature. Cutting element **154** may aid in puncturing and/or piercing a plastic sheet or barrier commonly wrapped around the water tank **12** of many water heaters during installation of the bracket **132**. It is contemplated that in some cases, the cutting element **154** may be omitted from the design, if desired.

In some embodiments, bracket **132** may also include two (or more) bosses **144** on a first lateral side, and two (or more) bosses **144** on a second opposing lateral side. While bracket **132** is shown having four bosses **144**, it is contemplated that bracket **132** may have any number of bosses **144** as desired, for example, but not limited to, one, two, three, or more. Additionally, it is contemplated that bosses **144** may be disposed on fewer than, or more than, two lateral sides. Bosses **144** may provide, among other things, an area for torque to be applied directly to the bracket **132** during installation. For example, an installation tool may grip and apply torque to bosses **144** to threadably engage threaded region **138** of sensor portion **136** with a threaded water heater spud on a water tank **12**. In some instances, bosses **144** may further include a rib **146** disposed between adjacent bosses **144**. Rib(s) **146** may provide additional support to the bracket **132**, and may also help prevent an installation tool from contacting the component retaining region **133** of bracket **132** during installation.

As discussed in greater detail with respect to FIG. **4**, a sensor assembly structure may be inserted into a void **152** that is molded or otherwise formed within sensor portion **136**. The sensor assembly structure may include one or more protrusions that may help to locate the sensor assembly structure within void **152** and/or limit penetration of the sensor assembly structure into void **152** while allowing a wiring harness to pass without being pinched. The one or more protrusions may align the sensor assembly structure with inwardly extending ribs **148** disposed on the inner walls of the sensor portion **136** and into the void **152**. The one or more protrusions, in cooperation with one or more ribs **148**, may in some instances help properly align and assemble the temperature sensor assembly within the sensor portion **136**. The one or more protrusions may also help ensure that sensor assembly is not installed in the wrong bracket. When the temperature sensor assembly is assembled within sensor portion **136**, the sensor may be disposed within an internal well **139** within the distal tip portion **142** of the sensor portion (see FIG. **9**).

FIG. **9** is a perspective view, partially in cross-section, of the illustrative but non-limiting mounting bracket of FIG. **8**. As discussed above, the void **152** within the sensor region **136** may include inwardly extending ribs **148**. Ribs **148** may extend any length along the void **152**, as desired. While ribs **148** are shown extending to a middle portion of threaded region **138**, it is contemplated in some embodiments, ribs **148** may extend past threaded region **138**. In other embodiments, ribs **148** may terminate short of threaded region **138**, or at any point within threaded region **138**. It is further contemplated that there may be any number of ribs **148** as desired, for example, but not limited to, one, two, three, four, or more. In some embodiments, sensor portion **136** may include one or more slots (not explicitly shown) for receiving one or more protrusions such as protrusion **62** that may help locate temperature assembly structure **150** within void **152** and/or limit penetration of temperature assembly structure **150** into void **152**.

FIG. **10** is another perspective view of the illustrative but non-limiting mounting bracket of FIG. **8**. In the illustrative but non-limiting example, the bracket **132** includes a number of outer ribs **164** extending along the back of component retaining region **133** of bracket **132** and to the first region **137** of sensor portion **136**. For clarity, not all ribs **164** have been identified with a reference numeral. In some cases, outer ribs **164** may not extend all the way to sensor portion **136**, while in other cases, ribs **164** may extend further along sensor portion **136** towards threaded region **138** (see FIG. **13**). The number of ribs **164** may vary as desired depending on the application. For example, bracket **132** may have zero ribs **164**, as few as one rib **164**, more than 14 ribs, or any other number of ribs **164** as desired. As shown, the ribs **164** may radiate out from the elongated stem of the sensor region **136**, but this is not required. In some cases, the ribs **164** may be outward extensions of the inwardly extending ribs **148** disposed on the inner walls of the sensor portion **136**, but this is not required.

It is contemplated that the ribs **164** may provide additional strength to bracket **132**. In some cases, the ribs **164** may be sufficient for the bracket **132** to withstand up to a 650 pound-force (lbf) or more static vertical load. When so provided, bracket **132** may resist accidental breakage. In the event bracket **132** breaks or fails, however, bracket **132** may have other built-in safety features to help prevent a user from being exposed to hot water from the water tank **12**, as will be discussed in more detail below with respect to FIG. **12**.

FIG. **11** is a top plan view of the illustrative but non-limiting mounting bracket **132** of FIG. **8**. As discussed above, and in some embodiments, one or more protrusions of a temperature sensor assembly may be positioned between internal ribs **148**. Internal ribs **148** may be radially spaced within void **152**. While ribs **148** are illustrated as equally spaced around the circumference of void **152**, it is contemplated that internal ribs **148** may be spaced at any distance desired, or may not be present at all. Additionally, while void **152** is illustrated as having a circular cross-section, it is contemplated that void **152** may have any cross-section shape as desired, such as, but not limited to, square, rectangular, elliptical, or polygonal. Further, while void **152**, and thus elongate sensor region **136**, is illustrated as being approximately centrally located within the component containing region **133**, it is contemplated that the elongate sensor region **136** may be offset from the center in any position desired.

A wiring harness may be configured to extend from a temperature sensor assembly and to a gas control unit, such as the gas control unit **18** illustrated in FIG. **1**. Component retaining region **133** may include retaining elements **167** for retaining such a wiring harness. Retaining elements **167** may be molded in such a way as to allow the use of an optical sensor in production to ensure that the wiring harness and/or sensor wires are properly installed. For example, bracket **132** may be molded such that an opening is present behind retaining elements **167**. While not explicitly shown, component retaining region **133** may also include retaining elements for retaining a water heater controller module and/or gas valve module, if desired.

FIG. **12** is a side view of the illustrative but non-limiting mounting bracket of FIG. **8**. Threaded region **138** may be configured to provide additional safety features to bracket **132**, if desired. Threaded region **138** may include a plurality of threads **170** spaced a distance apart. In some instances, the first exposed thread may create a stress riser and thus a fracture point for the bracket. Eliminating exposure of the first and other threads may reduce and/or possibly eliminate the stress riser. As such, and in some instances, threaded region **138** may be configured such that when the sensor portion **136** is fully threadably engaged within a water tank **12**, the outside thread **176** of the threaded region **138** is disposed within the threaded region of the spud of the water tank **12** (e.g. no threads of the threaded region extend external of the threads of the water heater spud). When so provided, the outside thread **176** of the threaded region **138** may be supported by the threads of the water heater spud. In some cases, the outside thread **176** may have an additional radius or filet along the outside root. This may help reduce a stress riser that may develop along the outside edge of the outside thread **176**. In some cases, the threaded region **138** may have a length that is less than the threaded spud thickness, but this is not required.

In some instances, it is contemplated that the outside (or first) thread **176** and the inside (or last) thread **174** may be begin/end on a lateral side of the sensor portion **136** when the bracket **132** is assembled with a threaded spud of a water heater **10**, as shown in FIG. **12**. In some embodiments, this orientation may reduce the stress at those points. In some instances, the last thread **174** may be a high stress point or stress riser if it was located at the top or bottom of the sensor portion **136** when assembled with the threaded spud of the water heater **10** instead of on a lateral side. Although it is not an absolute requirement, positioning the end of the threads laterally may increase the strength of the bracket **132**. In some instances, the beginning point of the first thread **176** and the termination point of the last thread **174** may be generally positioned on the same lateral side, but this is not required.

It is contemplated that geometric dimensioning and tolerancing may be used to control the angle and roundness of the threads **170**. In some embodiments, threads **170** may be spaced such that there are 13.9-14.0 threads per inch. In other embodiments, it is contemplated that there may be more or less threads per inch. In one example, an outside portion **178** of the threaded region **138** may be in tension while an inside portion **180** of the threaded region **138** may be in compression, and a middle portion of the threaded region **138** may be relatively stress-free. In another example, threads **170** may be spaced to ensure that the material in the threads **170** is in compression, and not in tension. In either case, this may tend to increase the strength of the threaded region **138** when torque is being applied during installation of the bracket **132**, as well as to support a vertically applied load. In some cases, threaded region **138** may be able to withstand 75 foot-pounds (ft-lbs), or more, of torque. In some embodiments, the root **172** of threads **170** may be rounded to relieve stress in the threads **170**. A round root **172** may increase the strength during application of torque as well as when vertical loads are applied.

In the event that a torque or a vertical load is applied to the bracket **132** that exceeds the design load limits, or the bracket **132** is otherwise sufficiently stressed, bracket **132** may break in a sudden manner resulting in a brittle fracture. A suitable material for creating such a break is DuPont™ Zytel® 70G33, however, other materials may be used. The stress from such an event may be concentrated in the last thread **170** that engages the water heater spud. A brittle material may result in a clean break at or near the outside edge of the water heater spud such that the portion of the sensor portion **136** that has been threadably engaged with the water heater spud remain positioned within the water heater spud. For example, if a breakage occurs, the distal portion **142** and most of the threaded region **138** of the sensor portion **136** may remain disposed within the water tank **12** and water heater spud. This may help prevent significant leakage of hot water from the water heater when a break occurs. Once the water is removed, or the water is cooled, the internal ribs **148** (see FIG. **11**) disposed within the void **152** may be used to axially align a removal tool, for example, an aggressive Easy-Out such as a Walton #4 pipe, stud, and screw extractor or equivalent, and to provide a surface to which torque may be applied to remove the broken off portion of the bracket **132** from the water heater spud. If ribs **148** are not present in the remaining portion of the sensor portion **136**, a removal tool having sharp blades may be used to dig into the interior surface of the internal well **139** to remove the broken off portion, if desired.

Returning briefly to FIG. **1**, it will be appreciated that gas control unit **18** may include a controller. FIG. **14** is a block diagram of such a controller **200**. The controller **200** may be considered as being a portion of gas control unit **18**, or separate from gas control unit **18**. Controller **200** may have several modules. In some cases, controller **200** may have an INPUT/OUTPUT block **202** that accepts signals from temperature sensor **28** (FIG. **1**) and/or temperature sensor assembly **49** (FIG. **3**). If water heater **10** is in communication with an external thermostat or other HVAC controller, INPUT/OUTPUT block **202** may accommodate externally-derived control signals, and/or provide status and/or other information, as desired. In some cases, INPUT/OUTPUT block **202** may also provide appropriate output command signals to an electrically controlled gas valve (not illustrated) within gas control unit **18**.

In some instances, controller **200** may include a microprocessor **204** that may be configured to accept appropriate signals from INPUT/OUTPUT block **202**, and to determine appropriate output signals that can be outputted via INPUT/OUTPUT block **202**, such as to other components within gas control unit **18** (FIG. **1**) and/or to an external thermostat or other HVAC controller. Microprocessor **204** may be programmed to accept a temperature signal from temperature sensing assembly **32**, **132** (FIGS. **3** and **8**), and to calculate or otherwise determine a command temperature that alters the temperature value received from the temperature sensing assembly **32**, **132** in order to account or compensate for temperature differentials and/or thermal lag caused by the partial thermal isolation (if present) of the temperature sensor **56** from the water in the water tank **12**. While not explicitly illustrated, microprocessor **204** may also include memory and/or other components. A further discussion of the operation of one illustrative controller **200** and algorithms can be found in co-pending U.S. patent application Ser. No. 12/255,592, filed Oct. 21, 2008, and entitled “WATER HEATER WITH PARTIALLY THERMALLY ISOLATED TEMPERATURE SENSOR”, the entirety of which is incorporated herein by reference.

The disclosure should not be considered limited to the particular examples described above, but rather should be understood to cover all aspects of the invention as set out in the attached claims. Various modifications, equivalent processes, as well as numerous structures to which the invention can be applicable will be readily apparent to those of skill in the art upon review of the instant specification.

We claim:

1. A bracket for a water heater with a water tank, the bracket comprising:

a polymeric body having a component retaining region and an elongated sensor portion extending from the component retaining region, the elongated sensor portion configured to receive a temperature sensor at least partially within the elongated sensor portion;

wherein the elongated sensor portion includes a threaded portion that is configured to threadably engage a threaded spud of the water heater such that at least part of the elongated sensor portion extends into the water tank of the water heater; and

wherein the threaded portion has a first thread and a last thread oriented such that the first thread begins and the last thread terminates on a lateral side of the threaded portion when the bracket is assembled with a water heater.

2. A bracket for a water heater with a water tank, the bracket comprising: a polymeric body having a component retaining region and an elongated sensor portion extending from the component retaining region, the elongated sensor portion configured to receive a temperature sensor at least partially within the elongated sensor portion; wherein the elongated sensor portion includes a threaded portion that is configured to threadably engage a threaded spud of the water heater such that at least part of the elongated sensor portion extends into the water tank of the water heater;

wherein the elongated sensor portion includes an elongated stem that has an internal well for receiving the temperature sensor; and

wherein the internal well is defined, at least in part, by a wall having one or more ribs, wherein the ribs are configured to properly position the temperature sensor within the well.

3. The bracket of claim **2**, wherein the threaded portion extends around the elongated sensor portion.

4. The bracket of claim **2**, wherein the elongated sensor portion has a distal end that terminates inside of the water tank when the bracket is installed on the water heater, and wherein the elongated sensor portion includes a thread lead in region between the threaded portion and the distal end of the elongated sensor portion, the thread lead in region guiding the bracket relative to the water heater before the threaded portion of the elongated sensor portion threadably engages the threaded spud of the water heater.

5. The bracket of claim **1**, wherein the elongated sensor portion has a distal end that terminates inside of the water tank when the bracket is installed on the water heater, and wherein the wall thickness of the threaded portion has a greater wall thickness than the distal end.

6. The bracket of claim **1**, wherein the elongated sensor portion has a distal end that terminates inside of the water tank when the bracket is installed on a water heater, and wherein the distal end includes a blade element to help pierce a barrier when the bracket is installed on a water heater.

7. The bracket of claim **1**, wherein the polymeric body includes a material that, when sufficiently stressed, fractures suddenly in a clean break.

8. The bracket of claim **7**, wherein the polymeric body includes DuPont Zytel 70G33.

9. The bracket of claim **1**, wherein the component retaining region includes two or more ribs for providing additional support to the component retaining region.

10. The bracket of claim **9**, wherein the component retaining region includes retaining elements for retaining a gas valve module.

11. The bracket of claim **10**, wherein the component retaining region includes retaining elements for retaining a water heater controller module.

12. The bracket of claim **8**, wherein the component retaining region includes a first boss along one lateral side and a second boss along the same lateral side, with a rib extending between the first boss and the second boss.

13. The bracket of claim **1**, wherein the polymeric body is molded as a single piece.

14. A bracket for a water heater with a water tank, the bracket comprising:

a body having a component retaining region and an elongated sensor region extending from the component retaining region, the elongated sensor region having an internal well for receiving a temperature sensor;

the elongated sensor region including a threaded portion that extends around the elongated sensor region for threadably engaging a threaded spud of a water heater such that at least part of the elongated sensor region extends into the water tank of the water heater;

the elongated sensor region having a first region positioned between the component containing region and the threaded portion, an outer surface of the first region defining a larger cross-sectional area than an outer surface of the threaded portion, and the threaded portion having a thinner wall thickness than the first region; and

the elongated sensor region further including a tapered region positioned between the threaded portion and the first region, the tapered region having a tapered wall thickness between the thinner wall thickness of the threaded portion and the thicker wall thickness of the first region.

15. The bracket of claim **14**, wherein the body is molded as a single piece from a polymeric material.

16. The bracket of claim **14**, wherein the threaded portion is configured such that, when the threaded portion is threadably engaged with the threaded spud, an outside region of the threaded portion is in tension and an inside region of the threaded portion is in compression.

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